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WORKSHOP ON THE PHYSICS AND MODELING  
OF SUBMICRON STRUCTURES

University of Illinois, Allerton House  
June 28-30, 1982

Final Report

K. Hess

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Coordinated Science Laboratory  
University of Illinois at Urbana-Champaign  
Urbana, IL 61801

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19. KEY WORDS (Continue on reverse side if necessary and identify by block number)  Submicron Structures Microelectronics		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number)  → A Workshop on the Physics and Modeling of Submicron Structures has been held. The results and lectures of the Workshop are briefly described.		

→ The purpose of this workshop was to increase and discuss the understanding of material and transport properties on the submicron scale and to stimulate interest among distinguished scientists in this challenging field. The number and standing of participating scientists showed clearly the growing interest in this area, which was further enhanced by the meeting.

Three major areas concerning submicron semiconductor structures were discussed:

- (i) Many papers were devoted to Monte Carlo simulations of "ballistic transport," velocity overshoot, and the simulation of device structures such as planar doped barriers (Ferry, Grubin, Littlejohn, the Cornell group, Leburton, and others). There was a general consensus that very high (ballistic) velocities, approaching  $10^8$  cm/s, can only be achieved if electrons are injected at higher energies. It also became clear that collisions play an important role even at very short times and that transport is never entirely ballistic (collision free) even down to device length of 100 Å in semiconductors such as GaAs and InP. Another important finding was that the supply voltages must be low (below the corresponding energies of the satellite valleys) to achieve high velocities. A discussion including details (intracollisional field effect, etc.) was given by Ferry. There were also substantial discussions of the role of contacts, electron-electron scattering, electron plasmon interaction and diffusion. All these effects are detrimental for ultrahigh speed.
- (ii) Many contributions were devoted to superlattices and semiconductor heterostructure layers. These contributions demonstrated clearly the high potential of these structures, which can easily be made ultrasmall

in one direction. Holonyak pointed out the opportunities of quantum well lasers, Döhler discussed the special properties of doping superlattices, Maradudin's lecture treated phonons in confined geometries, and Capasso dealt with superlattice avalanche photodiodes. It is clear from these talks that the variability of the boundary conditions in these structures opens a new area of semiconductor electronics. This was also stressed by Bardeen in his introductory talk and by G. J. Iafrate and Bruce McCombe in their overviews.

- (iii) The third major area discussed was the modelling of submicron devices. Several papers treated this subject in a more general way. Of special interest were the papers on the high mobility transistor (Linh and Delagebeaudeuf) which demonstrated ultrahigh speeds and the review and results of Grubin et al. on modelling considerations for VLSI devices.

The rest of the papers covered a wide area, ranging from a proposal of a terahertz oscillator to the design of current VLSI structures. A list of speakers and participants is attached. The manuscripts will be published by Plenum Press as the proceedings volume of the workshop.



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Speakers:

H. U. Baranger and J. W. Wilkins  
John Bardeen  
J. R. Barker  
Herbert Bennett  
Robert Buhrman  
F. Capasso  
Pallab Chatterjee  
Steven S. Cherensky and Peter A. Blakey  
Gottfried Döhler  
L. Eastman  
R. Fauquembergue, M. Pernisek, and E. Constant  
David K. Ferry  
D. K. Ferry, R. O. Grondin, R. K. Reich, H. L. Grubin, and G. J. Iafrate  
D. Greene  
Harold L. Grubin  
Karl Hess  
Nick Holonyak, Jr.  
Gerald J. Iafrate  
Johnson Lee, M. O. Vassell, and H. Lockwood  
Nguyen T. Linh and D. Delagebeaudeuf  
A. A. Maradudin  
Bruce McCombe  
M. W. Muller, P. Roblin, and D. L. Rode  
D. F. Nelson  
J. B. Socha, F. A. Buot, and J. A. Krumhansl  
R. J. Trew, R. Sultan, M. A. Littlejohn, and J. R. Hauser  
D. C. Tsui  
T. Wang, J. P. Leburton, and K. Hess  
T. H. Windhorn, L. W. Cook, T. J. Roth, and G. E. Stillman  
J. S. Ziegler

Panel Discussion Members:

L. Anderson  
D. Bimberg  
J. R. Brews  
L. Cooper  
J. Frey  
G. Gamota  
E. Gornik  
M. Littlejohn  
M. Nathan  
P. Price  
D. C. Tsui  
H. Wittmann

Preprints of Papers Presented:

Attached

List of Participants:

1. Karl Hess  
Conference Chairman  
Coordinated Science Laboratory  
University of Illinois  
1101 W. Springfield Ave.  
Urbana, IL 61801
2. S. J. Allen  
Bell Labs  
600 Mountain Ave.  
Murray Hill, NJ 07974
3. C. L. Anderson  
Hughes Research Lab  
3011 Malibu Canyon Road  
Malibu, CA 90265
4. Krishnan K. Bajaj  
AFWAL/AADR, Bldg. 450  
Avionics Laboratory  
Wright-Patterson AFB, OH 45433
5. H. U. Baranger  
Laboratory of Atomic and  
Solid State Physics  
Cornell University  
Ithaca, NY 14853
6. John Bardeen  
Department of Physics  
University of Illinois  
211 Loomis Laboratory  
1110 West Green St.  
Urbana, IL 61801
7. Robert T. Bate  
Texas Instruments, Inc.  
P.O.B. 225936  
M/S 118  
Dallas, TX 75265
8. Herbert S. Bennett  
National Bureau of Standards  
Bldg. 225, Rm. B352  
Washington, DC 20234
9. Dieter Bimberg  
Institut fuer Halbleitertechnik  
Rhein.-Westf. Techn. Hochschule  
Walter-Schottky-Haus  
Sommerfeldstrasse  
D-5100 Aachen, WEST GERMANY



10. Peter A. Blakey  
Electrical Engineering Dept.  
3519 East Engineering Bldg.  
University of Michigan  
Ann Arbor, MI 48109
11. Ed Boling  
Westinghouse Electric Company  
Advanced Technology Labs  
Winterson and Nursery Roads  
Linthicum, MD 21090
12. P. Boudreaux  
National Security Agency  
Ft. G. G. Meade, MD 20755
13. H. Bowers  
Hughes Aircraft  
P. O. Box 2999  
Torrence, CA 90509
14. Michael Bretz  
Department of Physics  
University of Michigan  
Ann Arbor, MI 48109
15. Robert Buhrman  
Department of Applied Physics  
Clark Hall  
Cornell University  
Ithaca, NY 14853
16. G. E. Bulman  
Department of Electrical Engineering  
University of Illinois  
155 Electrical Engr. Bldg. / EERL  
1406 W. Green St.  
Urbana, IL 61801
17. F. A. Buot  
School of Electrical Engineering  
Cornell University  
Ithaca, NY 14853
18. Federico Capasso  
Bell Labs  
600 Mountain Ave.  
Murray Hill, NJ 07974
19. Y. C. Chang  
Department of Physics  
University of Illinois  
212 Materials Research Laboratory  
104 S. Goodwin Ave.  
Urbana, IL 61801
20. Pallab Chatterjee  
Texas Instruments, Inc.  
P.O.B. 225936  
M/S 118  
Dallas, TX 75265

21. Jim Coleman  
Department of Electrical Engineering  
University of Illinois  
155 Electrical Engr. Bldg. / EERL  
1406 W. Green St.  
Urbana, IL 61801
22. R. K. Cook  
General Technology Division  
IBM  
Zip 45A  
Hopewell Junction, NY 12533
23. Larry R. Cooper  
Code 414  
Office of Naval Research  
Arlington, VA 22217
24. Gottfried Doehler  
Max-Planck-Institut fuer  
Festkoerperforschung  
Heisenbergstrasse 1  
Postfach 80 06 65  
7000 Stuttgart 80  
WEST GERMANY
25. W. P. Dumke  
IBM Thomas J. Watson Research Center  
Yorktown Heights, NY 10598
26. J. D. Dow  
Department of Physics  
University of Illinois  
327 Loomis Lab  
1110 W. Green St.  
Urbana, IL 61801
27. David J. Dumin  
Dept. of Electrical Engineering  
Clemson University  
Clemson, SC 29631
28. Jack R. East  
Electron Physics Laboratory  
Dept. of Electrical and  
Computer Engineering  
University of Michigan  
Ann Arbor, MI 48109
29. L. Eastman  
Department of Electrical Engineering  
Cornell University  
Ithaca, NY 14853
30. R. Fauquembergue  
Centre Hyperfrequences et  
Semiconducteurs  
Universite de Lille  
LA CNRS No. 287, Bat. P3  
59655 Villeneuve d'Ascq FRANCE

31. D. K. Ferry  
Dept. of Electrical Engineering  
Colorado State University  
Ft. Collins, CO 80523
32. William R. Frensley  
Texas Instruments, Inc.  
P. O. Box 225936  
M/S 134  
Dallas, TX 75265
33. Jeffrey Frey  
Phillips Hall  
Cornell University  
Ithaca, NY 14853
34. George Gamota  
Institute of Science and Technology  
University of Michigan (Physics)  
2200 Bonisteel Blvd.  
Ann Arbor, Michigan 48109
35. A. Ghis  
Centre Hyperfrequences et  
Semiconducteurs  
LA CNRS No. 287, Bat. P3  
Universite de Lille  
59655 Villeneuve d'Ascq FRANCE
36. Erich Gornik  
Institut fur Experimentalphysik  
Universitat Innsbruck  
Schopfstrasse 41  
A-6020 Innsbruck  
AUSTRIA
37. D. Greene  
Naval Research Laboratory  
Washington, DC 20375
38. Richard W. Griffith  
U.S. Army Research Office  
P. O. Box 12211  
Research Triangle Park, NC 27709
39. Robert Grondin  
Dept. of Electrical Engineering  
Colorado State University  
Ft. Collins, CO 80523
40. Harold L. Grubin  
Scientific Research Associates  
P. O. Box 498  
Glastonbury, CT 06033
41. Bob Hammond  
Mailstop D429  
Los Alamos National Laboratory  
Los Alamos, NM 87545
42. Jim Harvey  
U.S. Army RDES Group  
P.O. Box 65  
FPO, NY 04510

43. John R. Hauser  
232 Daniels Hall  
North Carolina State University  
Raleigh, NC 27650
44. Nobuo Hashizume  
Electrotechnical Laboratory  
Tsukuba  
JAPAN
45. P. Hesto  
Institut d'Electronique Fondamentale  
Bat. 220  
Faculte d'Orsay  
91405 Orsay CEDEX  
FRANCE
46. Karl R. Hofmann  
Siemens Research Laboratory  
Otto-Hahn-Ring 6  
D-8000 Muenchen 83  
WEST GERMANY
47. N. Holonyak, Jr.  
Department of Electrical Engineering  
University of Illinois  
155 Electrical Engr. Bldg. / EERL  
1406 W. Green St.  
Urbana, IL 61801
48. T. C. Hsieh  
Coordinated Science Laboratory  
University of Illinois  
1101 West Springfield Ave.  
Urbana, IL 61801
49. Gerald J. Iafrate  
DELET-ED-T  
U.S. Army Electronics Technology  
and Devices Laboratory  
Ft. Monmouth, NJ 07703
50. Carlo Jacoboni  
Istituto di Fisica  
Universita di Modena  
Via Campi 213/A  
41100 Modena, ITALY
51. H. Kraeutle  
Institut fuer Halbleitertechnik  
Rhein.-Westf. Techn. Hochschule  
Walter-Schottky-Haus  
Sommerfeldstrasse  
D-5100 Aachen, WEST GERMANY
52. Peter Krusius  
School of Electrical Engineering  
428C Phillips Hall  
Cornell University  
Ithaca, NY 14853

53. J. S. Lamming  
General Electric Company  
Hirst Research Centre  
East Lane, Wembley  
Middlesex HA9 7PP  
ENGLAND
54. Suzanne Laval  
Institut d'Electronique Fondamentale  
Bat 220  
Universite Paris Sud  
91405 Orsay Cedex  
FRANCE
55. J. P. Leburton  
Coordinated Science Laboratory  
University of Illinois  
1101 W. Springfield Ave.  
Urbana, IL 61801
56. Johnson Lee  
GTE Laboratory  
40 Sylvan Rd.  
Waltham, MA 02254
57. William T. Lindley  
MIT Lincoln Lab  
P.O. Box 73  
Lexington, MA 02173
58. D. Lippens  
Centre Hyperfrequences et  
Semiconducteurs  
Universite de Lille  
LA CNRS No. 287, Bat. P4  
59655 Villeneuve d'Ascq FRANCE
59. John W. Little  
Health and Safety Research Division  
Oak Ridge National Laboratory  
P.O. Box X  
Oak Ridge, TN 37830
60. M. A. Littlejohn  
Electrical Engineering Dept.  
232 Daniels Hall  
North Carolina State University  
Raleigh, NC 27650
61. Cole W. Litton  
Electronic Research Branch  
AFWAL/AADR, Bldg. 450  
Avionics Laboratory  
Wright-Patterson AFB, OH 45433
62. David Lowe  
Department of Physics  
University of Warwick  
Coventry CV4 7AL  
ENGLAND

63. P. Lugli  
Department of Electrical Engineering  
Colorado State University  
Ft. Collins, CO 80523
64. A. A. Maradudin  
Department of Physics  
University of California  
Irvine, CA 92717
65. David S. Matthews  
Hughes Aircraft Co.  
Research Labs  
3011 Malibu Canyon Rd.  
Malibu, CA 90265
66. Bruce D. McCombe  
Naval Research Laboratory  
Code 6800  
4555 Overlook Avenue S.W.  
Washington, DC 20375
67. Hadis Morkoç  
Coordinated Science Laboratory  
University of Illinois  
1101 W. Springfield Ave.  
Urbana, IL 61801
68. Marcel W. Muller  
Dept. of Electrical Engineering  
Campus Box 1127  
Washington University  
St. Louis, MO 63130
69. Marshall Nathan  
IBM Research Center  
Box 218  
Yorktown Heights, NY 10598
70. David Navon  
Dept. of Electrical and  
Computer Engineering  
University of Massachusetts  
Amherst, MA 01003
71. Nguyen Trong-Linh  
Thomson CSF  
Corbeville  
91401 Orsay  
FRANCE
72. D. F. Nelson  
Bell Laboratories  
600 Mountain Avenue  
Murray Hill, NJ 07974
73. Dee-Son Pan  
Electrical Engineering Department  
UCLA  
Los Angeles, CA 90024

74. Y. J. Park  
Dept. of Electrical and  
Computer Engineering  
University of Massachusetts  
Amherst, MA 01003
75. Deva N. Pattanayak  
Rockwell International  
P.O. Box 4761  
Dept. 526, HB16  
Anaheim, CA 92803
76. Dick Reynolds  
ARPA  
1400 Wilson Boulevard  
Arlington, VA 22209
77. R. H. Ritchie  
Oak Ridge National Lab  
Oak Ridge, TN 37830
78. Fred Rothwarf  
U.S. Army RDES Group  
P.O. Box 65  
FPO, NY 04510
79. A. G. Sabnis  
Bell Laboratories  
555 Union Blvd.  
2C125  
Allentown, PA 18103
80. Leonard Sander  
Department of Physics  
University of Michigan  
Ann Arbor, MI 48109
81. Melvin P. Shaw  
Dept. of Electrical Engineering  
Wayne State University  
Detroit, MI 48202
82. H. Shichijo  
MS 944  
Central Research Laboratories  
Texas Instruments, Inc.  
P. O. Box 225621  
Dallas, TX 75265
83. Barbara Abraham Shrauner  
Dept. of Electrical Engineering  
Washington University  
St. Louis, MO 63130
84. M. S. Shur  
Dept. of Electrical Engineering  
139 Electrical Engineering  
123 Church Street S.E.  
University of Minnesota  
Minneapolis, MN 55455

85. J. B. Socha  
Laboratory of Atomic and  
Solid-State Physics  
Cornell University  
Ithaca, NY 14853
86. G. E. Stillman  
Department of Electrical Engineering  
203 Electrical Engineering  
Research Lab
87. Philip Stover  
AFWAL/AADR, Bldg. 450  
Avionics Laboratory  
Wright-Patterson AFB, OH 45433
88. Ben G. Streetman  
Department of Electrical Engineering  
University of Texas at Austin  
P. O. Box 7728  
Austin, TX 78712
89. Steve Swierkowski  
M/S L-156  
Lawrence Livermore Lab  
P.O. Box 808  
Livermore, CA 94550
90. Ting-Wei Tang  
Electrical and Computer  
Engineering  
University of Massachusetts  
Amherst, MA 01003
91. D. C. Tsui  
Dept. of Electrical Engr.  
and Computer Science  
Princeton University  
Princeton, NJ 08544
92. C. Uher  
Department of Physics  
University of Michigan  
Ann Arbor, MI 48109
93. M. O. Vassell  
GTE Laboratories Inc.  
40 Sylvan Road  
Waltham, MA 02254
94. K. V. Vaidyanathan  
Hughes Aircraft Co. Research Labs  
3011 Malibu Canyon Road  
Malibu, CA 90265
95. Michael Waldner  
Hughes Aircraft Co. Research Labs  
3011 Malibu Canyon Road  
Malibu, CA 90265



96. Kang Wang  
UCLA  
Dept. of Electrical Engineering  
7731 Boelter Hall  
Los Angeles, CA 90024
97. T. Wang  
Coordinated Science Laboratory  
University of Illinois  
1101 W. Springfield Ave.  
Urbana, IL 61801
98. John W. Wilkins  
LASSP - Clark Hall  
Cornell University  
Ithaca, NY 14853
99. T. H. Windhorn  
Department of Electrical Engineering  
University of Illinois  
155 Electrical Engr. Bldg / EERL  
1406 W. Green St.  
Urbana, IL 61801
100. Gerald L. Witt  
AFOSR/NE  
Bolling AFB, D.C. 20332
101. Horst R. Wittmann  
U.S. Army Research Office  
P. O. Box 12211  
Research Triangle Park  
North Carolina 27709
102. George Wright  
Office of Naval Research  
Arlington, VA 22217
103. J. S. Ziegler  
IBM Research Center  
Yorktown Heights, NY 10598
104. J. Zimmermann  
Centre Hyperfrequences et  
Semiconducteurs  
Universite de Lille  
LA CNRS No. 287, Bat. P3  
59655 Villeneuve d'Ascq  
FRANCE

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